Bonneville Power Administration
Fish and Wildlife Program FY99 Proposal

Section 1. General administrative information

Effects of catch and release angling and exhaustive stress on the physiology, mortality, and reproductive performance of white sturgeon

Bonneville project number, if an ongoing project 9134

Business name of agency, institution or organization requesting funding
U.S. Geological Survey, Biological Resources Division, Columbia River Research Laboratory

Business acronym (if appropriate) USGS-CRRL

Proposal contact person or principal investigator:

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Subcontractors.

Organization	Mailing Address	City, ST Zip	Contact Name

NPPC Program Measure Number(s) which this project addresses.

10.1 Resident fish, 10.4 Sturgeon mitigation

NMFS Biological Opinion Number(s) which this project addresses.

Other planning document references.

Subbasin.

Lower Mid-Columbia River Mainstem, Lower Snake River Mainstem, Upper Columbia River, Upper Snake River

Short description.

Use physiological telemetry to monitor metabolic activity, determine energetic costs, and assess stressful effects of catch and release angling and exhaustive stress in white sturgeons.

Section 2. Key words

Mark	Programmatic Categories	Mark	Activities	Mark	Project Types
	Anadromous fish		Construction		Watershed
x	Resident fish		O & M		Biodiversity/genetics
	Wildlife		Production	x	Population dynamics
	Oceans/estuaries	x	Research		Ecosystems
	Climate		Monitoring/eval.		Flow/survival
	Other		Resource mgmt		Fish disease
			Planning/admin.		Supplementation
			Enforcement		Wildlife habitat en-hancement/restoration
			Acquisitions		

Other keywords.

Sturgeons, physical stress, bioenergetics, physiological telemetry, catch and release angling, survival, mortality, reproduction

Section 3. Relationships to other Bonneville projects

Project #	Project title/description	Nature of relationship

Section 4. Objectives, tasks and schedules

Objectives and tasks

Obj 1,2,3	Objective	Task a,b,c	Task
1	**Examine the relation between**	A	Obtain or construct a swimming

	telemetered physiological variables, oxygen consumption, and physiological indicators of stress in white sturgeon.		respirometer for large fish. Set up wet laboratory holding and testing facilities.
		B	Obtain a few physiological telemetry tags and related equipment for lab testing. These would include heart rate, ventilation rate, and electromyogram (EMG) tags; tags can be reused several times. Obtain detailed instructions and methods for surgical implantation of tags.
		C	Collect white sturgeon from the Columbia River and transport them to our laboratory. Maintain fish under ambient conditions. Fish should be about 0.9-1.5 m in length. Hold fish for several weeks prior to testing
		D	Surgically implant tags in fish, placing only one tag in each fish. Cannulate fish for repeated sampling of blood. Check for proper operation of the biotelemetry system. Allow several days for recovery while telemetering the variable of interest and maintaining patency of the cannula.
		E	Subject fish to a respirometry trial. Conduct a U-critical swimming challenge with fish while simultaneously measuring oxygen consumption, monitoring telemetry signals (i.e., heart rate, ventilation rate, or EMG), and periodically taking blood samples
		F	Examine relations between telemetered data, oxygen consumption, physiological indicators of stress, and individual fish. Derive best fit regression

			equations for the relation between telemetered data and oxygen consumption.
2	**Assess the effects of catch and release angling on metabolic rate and selected physiological indicators of stress in wild white sturgeon**	A	From the wild, capture several large sturgeon with either set lines or angling. Transport fish back to the laboratory and surgically implant tags into fish or implant tags *in situ*. Monitor recovery from surgery, tag implantation, and tag output for a few days
		B	Release fish back to their point of capture. As an alternative, fish could be transported to smaller, isolated backwaters to potentially increase the efficacy of the recapture phase of this objective (see below). Monitor physiological function and movement for several weeks to establish baseline metabolic rate data.
		C	Using the telemetry system, locate fish and attempt to capture tagged fish by angling. Monitor physiological function during the angling process. Monitor time of hookup and playing time. Upon landing the fish, draw a quick blood sample from the caudal vasculature, photograph the fish and the site of surgery, and release the fish.
		D	Determine the stressful effects of angling. After release, monitor physiological function for several days. Compare the metabolic response to angling with the baseline metabolic rate data collected prior to angling. Assess rate of recovery and correlate metabolic rate data with physiological information obtained from the laboratory.

3	**Document the occurrence and determine the extent of any postangling mortality**	A	Use physiological telemetry and fish movement and location data to assess postangling mortality
4	**Assess the effects of exhaustive stress on selected aspects of white sturgeon reproductive performance**	A	Locate facilities for long term rearing of large, broodstock sturgeon. This could be at our laboratory or an established sturgeon aquaculture facility
		B	Obtain several reproductive age female sturgeon from the wild or an established aquaculture facility. Stock fish in each of 4 large tanks for rearing. There will be two treatments (stressed and controls) with two replicate tanks per treatment. Maintain fish under ambient conditions
		C	During rearing, monitor reproductive physiology and state of maturation by periodically sampling blood for sex steroid analysis and conducting ovarian biopsies as per standard aquaculture procedures.
		D	Administer various stressors to fish in two tanks (i.e., the treatment fish) at selected intervals during rearing and prior to sexual maturation. The stressors should be varied to minimize fish becoming accustomed to one type of stressor. Stressors could include dewatering and hypoxia, chasing until exhaustion, and netting fish and suspending in air
		E	Spawn treatment and control fish using a single sperm sample and standard aquacultural methods. Record female weight, total length, weight of the eggs, and ovarian fluid weight
		F	Using subsamples of eggs from each female, weigh to the nearest

			0.01 g and measure the diameter to the nearest 0.01 mm each egg in the subsample (ca. 50 eggs per female). Determine the gonadosomatic index, absolute and relative fecundity, and the percentage of fertilized eggs for each female
		G	Determine the mean percent of embryos hatching and monitor growth of fry at 2, 4, 6, and 8 weeks after absorption of the yolk sac. Monitor embryo, fry, and juvenile mortality twice a week.

Objective schedules and costs

Objective #	Start Date mm/yyyy	End Date mm/yyyy	Cost %
1	10/1998	06/2000	20
2	04/2000	10/2002	55
3	04/2000	10/2002	5
4	10/1999	10/2002	20

Schedule constraints.

It will likely be necessary to have objective 1 mostly complete before commencing objectives 2 and 3. Any delays to objective 1 will cause delays in other objectives. To put the complete focus on objective 1 during the first year, objective 4 will be delayed one year.

Completion date.
2002

Section 5. Budget

FY99 budget by line item

Item	Note	FY99
Personnel	Res. Fish. Biol. GS-12/3 @ $4,116/mo. for 12 mo. Fish. Biol. GS-7/1 @ $2,175/mo. for 12 mo.	$75,492
Fringe benefits	@28% of personnel	$21,137
Supplies, materials, non-expendable property	Swimming respirometer and associated equipment, biotelemetry system, wetlab	$44,000

	and physiological assay supplies	
Operations & maintenance		$0
Capital acquisitions or improvements (e.g. land, buildings, major equip.)		$0
PIT tags	# of tags:	$0
Travel	20 d of boat use @ $150/d, vehicle rental @250/mo for 12 mo., vehicle mileage 3,000 mi @ $0.31/mi, meeting attendance	$8,000
Indirect costs	@ 38%	$56,479
Subcontracts		
Other		
TOTAL		$205,108

Outyear costs

Outyear costs	**FY2000**	**FY01**	**FY02**	**FY03**
Total budget	$300,000	$320,000	$155,000	
O&M as % of total	10%	10%	0%	

Section 6. Abstract

The white sturgeon is a species critically affected by hydroelectric development. Because of the declining status of many sturgeon populations, catch and release angling has become a central part of current fisheries management activities directed at sustaining or recovering populations of these fish. However, the potential detrimental effects of catch and release angling on these fish have never been addressed. We propose to examine the effects of catch and release angling on the stress physiology, reproductive physiology, and mortality of white sturgeon in laboratory and field studies. This research will use a multi-disciplinary approach that will focus on state-of-the-science physiological telemetry techniques to assess the effects of angling stress on fish in the wild. Data from the laboratory on the physiological responses and metabolic costs of physical stress in white sturgeon will be coupled with metabolic rate data obtained by physiological telemetry from fish angled in the wild to allow an assessment of catch and release angling. This project should be relevant to the resident fish goal and sturgeon mitigation as described in section 10 of the FWP. Results from this study should be complete within 3-4 years and will enable fisheries managers to make more informed decisions regarding the use of catch and release angling as a management tool for sustaining or recovering populations of white sturgeons. The study could be used to decide if seasonal closures to angling are warranted to protect spawning fish or to improve survival of fish during the summer when water temperatures are at their highest.

Section 7. Project description

a. Technical and/or scientific background.

The white sturgeon is one of the Pacific Northwest=s most important recreational fish and currently supports the largest sport fishery in terms of effort in the Columbia Basin (Devore et al. 1995). However, several populations of white sturgeon in the Columbia Basin are sparse and declining, primarily as a result of hydroelectric development. This has resulted in a variety of management activities by state agencies to help preserve sensitive stocks, including angling regulations such as slot-length limits to protect sexually mature fish, reduced harvest limits and seasons, and the use of barbless hooks only. Regulations such as these are necessary since white sturgeon in the Columbia Basin have a long history of stock collapse due to overexploitation (Craig and Hacker 1940). In fact, the longevity, slow growth, and delayed maturation of sturgeons make them particularly vulnerable to overexploitation and changes in their environment (Birstein 1993; DeVore et al. 1995; Miller et al. 1995).

Because of current angling regulations and increased recognition by anglers that trophy-sized fish can be readily hooked, increasing numbers of white sturgeon are now being released shortly after they are landed. Opportunities to hook and land Atrophy≅ white sturgeons are promoted by a number of commercial fishing guides throughout the basin. Although this Acatch and release≅ angling is widespread and is actively promoted as a method to conserve white sturgeon stocks, nothing is known about the biological effects of catch and release angling for this species. Information on the post-angling survival and physiology of white sturgeon would be helpful to fishery managers in evaluating current and developing new regulations to sustain these sensitive fish stocks.

Angling is one of the most severe forms of exhaustive exercise that a fish can experience (Booth et al. 1995). Many studies have shown that exhaustive exercise, including angling, results in a variety of severe physiological disturbances in different species of fish (Wydoski et al. 1976; Wood et al. 1983; Tufts et al. 1991; Pankhurst and Dedual 1994; Booth et al. 1995; Tomasso et al. 1996; Wilkie et al. 1996). Several studies have also documented delayed mortality after exhaustive exercise or angling for a variety of species, including rainbow trout *Oncorhynchus mykiss* (Bouck and Ball 1966; Ferguson and Tufts 1992), Atlantic salmon *Salmo salar* (Wilkie et al. 1996), muskellunge *Esox masquinongy* (Beggs et al. 1980), walleye *Stizostedion vitreum* (Fielder and Johnson 1994), and striped bass *Morone saxitalis* (Tomasso et al. 1996). In contrast, other investigators have found little association between exhaustive exercise and postexercise mortality (Wydoski et al. 1976; Gustaveson et al. 1991; Tufts et al. 1991; Pankhurst and Dedual 1994). Discrepancies between studies not only indicate that additional factors may influence postangling survival (Wilkie et al. 1996) but also presents difficulties in attempting to apply these results to unstudied species.

In addition to physiological dysfunction and delayed mortality, exhaustive exercise (and many other types of stressors) may alter several aspects of reproduction in fish. For example, several studies have demonstrated that stress may severely alter levels of reproductive hormones in fish (Pickering et al. 1987; Carragher et al. 1989; Carragher and Pankhurst 1991; Melotti et al. 1992; Pankhurst and Dedual 1994). Cortisol, the corticosteroid hormone secreted by fish in response to a variety of environmental stressors, has been shown to inhibit production of estradiol and testosterone by ovarian follicles of rainbow and brown *S. trutta* trout (Sumpter et al. 1987; Carragher and

Sumpter 1990). Campbell et al. (1992) reported that exposure of female hatchery rainbow trout to acute stress resulted in smaller egg size, delayed ovulation, and lower survival of larvae compared to unstressed fish. In contrast, Booth et al. (1995) found no significant differences in the hatching success of eggs between groups of angled and nonangled Atlantic salmon, but cautioned that angling may affect other aspects of reproduction, such as spawning behavior.

Although some areas of the Columbia River have been closed to angling prior to and during the spawning period for white sturgeon, many areas remain open to angling during this time. Also, the size limit regulations for white sturgeon that are in effect do protect sexually mature fish from being harvested, but such fish are nevertheless commonly captured and then released for sport. Clearly, an understanding of the effects of catch and release angling on reproductive physiology is necessary for a complete evaluation of this practice.

Physiological telemetry has proven to be a useful tool for evaluating various aspects of the physiology and behavior of fish in the wild. This technique involves recording transmissions of physiological parameters such as heart rate, ventilation rate, or axial muscle contractions that are strongly correlated with oxygen consumption. For example, detailed *in situ* measurements of locomotor activity, selected aspects of metabolism, and feeding activity have been made for a variety of fishes using transmissions of heart rate (Priede and Tytler 1977; Lucas et al. 1991; Sureau and Lagardere 1991), ventilation rate (Rogers and Weatherly 1983), and axial muscle electromyograms (EMGs; Weatherly et al. 1982; Demers et al. 1996; Hinch et al. 1996; Booth et al. 1997; Briggs and Post 1997).

Because of the success of physiological telemetry in evaluating the physiology and behavior of fish in the wild, we believe this technique will allow a rigorous assessment of the stressful effects of catch and release angling on white sturgeon. Stress in fish is also known to increase heart rate, ventilation rate, and oxygen consumption (Mazeaud et al. 1977; Barton and Schreck 1987; Peters et al. 1988; Laitinen and Valtonen 1994; Huuskonen and Karjalainen 1997). For example, Laitinen and Valtonen (1994), using a biotelemetry system, found that both heart and ventilation rate of brown trout were elevated for 3 to 4 days following a handling stress. Barton and Schreck (1987) documented that minor physical disturbances elicited a more than twofold increase in the metabolic rate of juvenile steelhead and estimated that the energetic cost of such stress was about one-quarter of the scope for activity of the fish. In addition, there is increasing evidence of a positive relation between plasma cortisol level and metabolic rate (i.e., oxygen consumption) in stressed fish (Chan and Woo 1978; Barton and Schreck 1987; Morgan and Iwama 1996) which we believe substantiates the use of metabolic rate as an indicator of stress in fish. By combining laboratory derived relations between metabolic rate and physiological variables (i.e., heart rate, ventilation rate, EMGs, and classic physiological indicators of stress) with telemetered data from white sturgeon angled in the wild, it should be possible to provide a unique and powerful means of assessing the energetic costs of capture and release, the time needed for recovery, and the extent of any post-angling mortality.

b. Proposal objectives.

1. Examine the relation between telemetered physiological variables, oxygen consumption, and physiological indicators of stress in white sturgeon.

AThere is no significant relation between physiological telemetry (i.e., heart rate, ventilation rate, or EMG) output and oxygen consumption≅
AThere is no significant relation between oxygen consumption and physiological indicators of stress≅

2. Assess the effects of catch and release angling on metabolic rate and selected physiological indicators of stress in wild white sturgeon.

ACatch and release angling is not stressful to white sturgeon≅

3. Document the occurrence and determine the extent of any postangling mortality.

ACatch and release angling does not cause significant postangling, delayed mortality in white sturgeons≅

4. Assess the effects of exhaustive stress on selected aspects of white sturgeon reproductive performance.

ACatch and release angling has no significant effects on reproduction of individuals in white sturgeons≅

c. Rationale and significance to Regional Programs.

Current fisheries management activities directed at sustaining or recovering populations of white sturgeon are a direct response to the deleterious effects of hydroelectric development. We consider catch and release angling as a management strategy responding to the detrimental effects of the hydroelectric system and therefore believe this strategy requires a complete evaluation to help assess its efficacy. Already, angling for white sturgeons has been prohibited in two areas--the Kootenai River in northern Idaho, where white sturgeons are listed as endangered, and that portion of the Columbia River upstream from the international border between the U.S. and Canada. These areas were closed to angling because of concerns that the stress associated with handling could either cause mortality or reproductive failure in mature fish. Fisheries managers recognize the value in providing the public with the opportunity to fish for and potentially catch large white sturgeons. However, the effects of catch and release fishing on the survival or reproduction of these fish have never been addressed.

The recently completed ABiological Risk Assessment for the Upper Snake River White Sturgeon≅ (Biological Risk Assessment Team 1997), prepared for the Nez Perce Tribe under section 10.4A.4 of the FWP and funded by the BPA, listed the need to evaluate the consequences of catch and release fishing as the *highest* research priority to address in the efforts to recover the population of white sturgeons found in the Snake River between Lower Granite Dam and Hells Canyon Dam. The project described herein is relevant to the resident fish goal as outlined in section 10.1 of the FWP in that it will provide much needed information to help assess measures designed to protect and recover white sturgeon stocks. This project specifically addresses several priorities for implementing resident fish policies and projects, as discussed in section 10.1B of the 1995 amendments to the FWP, including Aaccord highest priority to weak, but recoverable, native populations injured by the hydropower system...≅ and Aaccord high priority to populations that support important fisheries...including sturgeon...≅. Finally, this project is clearly relevant to several aspects of section 10.4 of the FWP dealing with sturgeon mitigation. This project can be completed relatively quickly, has a high potential for success and learning new information, addresses concerns being discussed by the Nez Perce tribe (as described above), and may be helpful to other agencies or tribes in addressing the extent of fishing mortality in white sturgeon (e.g., section 10.4A.6 of the 1995 amendments to the FWP).

d. Project history

e. Methods.

Objective 1. Examine the relation between telemetered physiological variables, oxygen consumption, and physiological indicators of stress in white sturgeon. We will use swimming respirometry to determine the relation between metabolic rate (i.e., oxygen consumption) and the physiological variable of choice (i.e., heart rate, ventilation rate, or EMG=s; see Lucas et al. (1993) for a complete review of methodology). We will obtain or build a Blazka or Brett-type swimming respirometer large enough to swim sturgeon from about 0.9-1.5 m in length. We will obtain fish from the wild by angling or set-lining and transport them to our laboratory. Fish will be held in large circular tanks at our laboratory under low densities and ambient environmental conditions. They will be fed daily with live or dead juvenile salmonids. Fish will be held for at least two weeks prior to the start of respirometry trials. We anticipate needing only a few (e.g., 6-10) fish to complete this objective.

We will obtain a few sonic or radio tags designed to telemeter either heart rate, ventilation rate, or EMG=s from established manufacturers . We will also obtain all equipment necessary to monitor telemetered signals and determine the ideal operating conditions for the system. Much of this equipment we already have at our laboratory. Tags will be surgically implanted in fish according to methods described in Priede and Young (1977), Kaseloo et al. (1992), and McKinley and Power (1992). In addition to the these references, we will obtain hands-on instruction in surgical tag implantation from Steve Peake at Simon Fraser University, who has extensive experience with the techniques involved. We will also surgically implant cannulas into fish for repeated sampling of blood during respirometry trials. Cannulas will be placed in either the dorsal aorta, branchial vasculature, or caudal vasculature according to standard techniques (see Schreck and Moyle 1990). Surgeries will be performed on all fish during a 1-3 day period, after which fish will be held in their tanks for at least a week to recover and to test the telemetry system.

To begin a respirometry trial, a fish will be chosen at random, placed in the respirometer, and allowed a period of acclimation to low water velocity. During acclimation, the swimming chamber will be flushed with oxygen-saturated freshwater. There will likely be an electric grid at the downstream end of the swim chamber to encourage fish to constantly swim. After acclimation, we will subject each fish to a U-critical swimming test by incrementally increasing water velocity at set time intervals until fish become fatigued. Oxygen concentrations in the respirometer will be determined at set intervals (e.g., every 5 min) using calibrated oxygen meters or Winkler titrations of water samples. Telemetered data will be continuously recorded and averaged over the set intervals. Blood samples will also be taken periodically during and after the swimming trial. Experiments will be carried out over the range of temperatures likely to be experienced by these fish in the wild.

Resultant data will be analyzed using regression analysis and analysis of covariance to determine the nature of the relation between oxygen consumption (i.e., metabolic rate) and the physiological variable of interest. Based on the literature, we fully expect at least one physiological variable to be highly correlated with metabolic rate. Blood samples will be assayed for various indicators of stress, including but not limited to such factors as plasma cortisol and lactate. We will also assess the relation between such Aclassical≅ indicators of stress and metabolic rate.

Objective 2. Assess the effects of catch and release angling on metabolic rate and selected physiological indicators of stress in wild white sturgeon. Based on our laboratory results from the first objective, we will obtain several (e.g., 10-15) physiological sonic or radio tags that will telemeter the variable of choice. We will capture sturgeon from the wild using angling or set lines and either surgically implant tags *in situ* or transport fish back to our laboratory for tag implantation. Our preference is to implant tags *in situ*, but our results from objective 1 may indicate that implatation under more controlled conditions is more prudent. In addition, it may be desirable to double tag fish with two different types of tags. For example, EMG tags may provide information during the hooking and playing process, whereas heart rate tags may yield the best metabolic rate information after release. After tag implantation, fish will be released back to their point of capture.

After release, we will monitor physiological function and fish movement for several weeks to establish baseline metabolic rate data. Data should be collected for a period sufficient to account for recovery from surgery and diel variations in metabolic rate. After collecting sufficient baseline metabolic rate data, we will use the telemetry system to precisely locate the fish and attempt to capture the tagged fish by angling. This technique has been used successfully in other areas. For this concentrated, intense angling effort, we will use one or both of these strategies: (1) agency boats equipped with several rod and reel outfits or (2) enlist private sportsmen or angling groups to conduct the angling. We surmise this project would be of interest to anglers and to maximize participation could offer a monetary Aprize≅ to the angler catching the tagged fish. When a tagged fish is hooked, which should be indicated by an abrupt change in tag output, we will note the time of hookup and the playing time. We will monitor physiological function during the angling process using tag output. Upon landing the fish, we will draw a quick blood sample, photograph the fish and the site of surgery, and release the fish.

After release, we will monitor physiological function of fish for several days in a manner identical to that during baseline data collection. Telemetered physiological data, in conjunction with our laboratory-derived relations, will be used to estimate oxygen consumption of angled fish. We will then compare oxygen consumption of angled fish at various intervals post-release to that of resting laboratory fish and the baseline data to determine the metabolic cost (i.e., the stressful effects) of catch and release angling. Plasma samples taken from fish in the wild will be assayed for physiological indicators of stress and values compared with those from fish used in the respirometry experiments. Because of the data intensive nature of this work and other logistical considerations, we anticipate tagging and releasing less than 10 fish per field season.

Objective 3. Document the occurrence and determine the extent of any postangling mortality. Work addressing this objective will be conducted simultaneously with that of objective 2. Basically, we will monitor the physiology and movements of fish post-release for a period of time sufficient to allow a reasonable determination of whether the fish survived. We will use a lack of tag output and fish movements as evidence, but not conclusive proof, that an angled fish has not survived. There are two critical assumptions associated with this objective: (1) the fish has not lost its tag and (2) the tag is functioning properly during the post-release monitoring period. Two pieces of information will help in meeting these assumptions: (1) when the fish is landed after angling, we will be able to assess the condition of the surgery site and hence obtain some indication of the possibility of losing the tag in the future and (2) the tags should be large enough to have a battery that will last several months. At the end of the field season, we will simply tally the number of fish that may not have survived the angling event.

Objective 4. Assess the effects of various physical stressors on selected aspects of white sturgeon reproductive performance. Work conducted for this objective will be based upon that described by Contreras-Sanchez (1995). We will establish facilities at our laboratory for the long-term rearing of adult sturgeon or, if necessary, will obtain rearing space at an established aquaculture facility. We will obtain several reproductive age (or size) female sturgeon from the wild or from an established aquaculture facility. Fish will be stocked into each of 4 large, circular tanks that will receive water of ambient temperature during the year. Fish will be fed a diet of live and dead juvenile salmonids. There will be two treatments, stressed and controls, with two replicate tanks per treatment.

During rearing, we will monitor reproductive physiology and state of maturation by periodically sampling blood for sex steroid analysis and conducting ovarian biopsies using standard aquacultural procedures. These sampling episodes will be at the minimum necessary to increase our chances of successful spawning. We will also administer various stressors to fish in two tanks (i.e., the treatment fish) at selected intervals during rearing and prior to sexual maturation. We will vary the stressors to minimize fish becoming accustomed to one type of stressor. The stressors may include, but will not be limited to, dewatering and hypoxia, chasing the fish to exhaustion, and netting fish and suspending in air.

When fish are sexually mature, we will spawn all treatment and control fish using standard aquacultural procedures. We will use a single, pooled sperm sample from several males to fertilize the eggs. We will record female weight, total length, weight of the eggs, and ovarian fluid weight. All eggs will be incubated in separate chambers. Using subsamples of eggs from each female, we will weigh and measure the diameter of each egg in the subsample (ca. 50-100 eggs per female). The gonadosomatic index, absolute and relative fecundity, and the percentage of fertilized eggs for each female will be determined. We will determine the mean percent of embryos hatching and monitor growth of fry at 2, 4, 6, and 8 weeks after absorption of the yolk sac. We will monitor and tally embryo, fry, and juvenile mortality twice a week.

We will use analysis of variance (ANOVA) as a check on randomization for a similar distribution of fish size throughout all tanks. Data from within each tank will be pooled for analysis, and we will check for tank effects between replicates using t-tests, or, if data distribution warrants it, their nonparametric equivalents. For all pairwise comparisons between treatments, we will use t-tests or nonparametric equivalents. We will use correlation and regression analyses to assess the relation between egg and fry size, and egg size and mortality and compare the relations between treatments. The level of significance for all tests will be 0.05.

f. Facilities and equipment.

We anticipate that all of the laboratory work for this project will be conducted at our Columbia River Research facility. Our laboratory, which has a long history of conducting research throughout the basin, has a fully equipped wet laboratory as well as several dry laboratories for conducting physiological assays. Our hope is to borrow a respirometer for completion of objective 1, but one could be constructed if necessary. We plan on drawing on the experience of Dr. Joseph Cech of UC-Davis to assist in this endeavor. Our staff has several individuals who are well versed in the art and science of wildlife telemetry, and we plan on using their experience to assist us in this project. In addition, we have an extensive array of state-of-the-art telemetry equipment from which to draw upon to conduct this research. Our laboratory is also well equipped with a variety of vessels of all sizes to conduct a wide array of field work. Our office is well supplied with all the modern equipment, computers, and analysis software necessary to complete this research. In short, our laboratory already has much of the equipment and technology necessary to complete this research, which we believe will result in substantially lower costs.

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Section 8. Relationships to other projects

This project is unique and should complement the efforts being made by fisheries managers working to restore white sturgeon populations throughout the Columbia River basin. There is potential for collaborative efforts with tribal or other groups that have expressed concern about the issue of catch and release angling of sturgeon.

Section 9. Key personnel

Matthew G. Mesa, Research Fishery Biologist, 1.0 FTE

Experience

1991-Present	Research Fishery Biologist, U.S. Geological Survey, Biological Resources Division, Columbia River Research Lab, Cook, WA Current responsibilities: Team leader on research projects addressing the effects of dissolved gas supersaturation on juvenile salmonids and evaluating predator-prey relations in Columbia River fishes
1989-1991	Fishery Biologist, U.S. Fish and Wildlife Service, Seattle-NFRC, Columbia River Field Station, Cook, WA
1986-1989	Fishery Biologist/CEA Appointee, Seattle-NFRC, Oregon Cooperative Fisheries Research Unit, Oregon State University, Corvallis, OR
1984-1986	Fishery Biologist, U.S. Fish and Wildlife Service, Seattle-NFRC, Columbia River Field Station, Cook, WA

Education:	School	Degree and Date Received
	California Polytechnic State Univ. at San Luis Obispo	B.S., Nat. Res. Mgt., 1984
	Oregon State Univ.	M.S., Fisheries, 1989
	Oregon State Univ.	Advancement to candidacy for Ph.D, 1995

Expertise: My areas of expertise include predator-prey interactions in fishes, fish behavior and performance, and general and stress physiology of fishes

Publications and Reports

Mesa, M.G. and C.B. Schreck. 1989. Electrofishing mark-recapture and depletion methodologies evoke behavioral and physiological changes in cutthroat trout. Transactions of the American Fisheries Society 118:644-658.

Mesa, M.G., and T.M. Olson. 1993. Prolonged swimming performance of northern squawfish. Transactions of the American Fisheries Society 122:1104-1110.

Mesa, M.G. 1994. Effects of multiple acute stressors on the predator avoidance ability and physiology of juvenile chinook salmon. Transactions of the American Fisheries Society 123:786-793.

Mesa, M.G., T.P. Poe, D.M. Gadomski, and J.H. Petersen. 1994. Are all prey created equal? A review and synthesis of differential predation on prey in substandard condition. Journal of Fish Biology 45 (Supplement A):81-96.

Mesa, M.G., T.P. Poe, A.G. Maule, and C.B. Schreck. *In press*. Vulnerability to predation and physiological stress responses in juvenile chinook salmon experimentally infected with *Renibacterium salmoninarum*. Canadian Journal of Fisheries and Aquatic Sciences.

Michael J. Parsley, Research Fishery Biologist, 0.05 FTE

School	Degree	Date
Iowa State University	B.S. Fisheries & Wildlife Biology	1982
University of Wisconsin	M. S. Fisheries	1984

Certified by the American Fisheries Society as a Fisheries Scientist in 1990

Current Employer: U.S. Geological Survey - Biological Resources Division

Current Responsibilities: I serve as project leader for studies done by staff at our facility on the early life history and habitat use of white sturgeons in the Columbia River. The studies have included the use of biotelemetry to ascertain habitat use by juvenile and adult white sturgeons, laboratory experiments to determine the effects of gas supersaturation on developing embryos, and the use of trawls to estimate recruitment to young of the year. My role is to coordinate our research activities on white sturgeons with the activities and needs of the tribes, states, and other governmental agencies. I oversee the work of several biologists and technicians who collect and analyze data pertaining to our studies to ensure that our work is of the highest quality and that it is done in accordance with established standards and protocols, such as the Good Laboratory Practices Act.

I also serve as the geospatial technology coordinator for the Western Fisheries Research Center.

Recent Previous Employment: Research Fisheries Biologist, U.S. Geological Survey, Biological Resources Division, Columbia River Research Laboratory, 1984 - present.

Expertise: My area of expertise is Fisheries Research, and I=m considered an expert on the ecology and biology of white sturgeons. In 1993 I organized and co-chaired a day-long symposium called ABiology and Management of North American Sturgeons≅ that was held at the Annual Meeting of the American Fisheries Society, Portland, Oregon, 1993. I=m also knowledgeable in methods to quantify habitat in large rivers using remote sensing and geographic information systems.

Recent Relevant Publications:

Parsley, M. J. 1992. Use of a raster structured GIS in fisheries research activities on the Columbia River. in F. D'erchia, editor, Proceedings of the Third National U.S. Fish and Wildlife Service Geographic Information Systems Workshop. May 1992, LaCrosse, Wisconsin.

Parsley, M. J., L. G. Beckman, and G. T. McCabe. 1993. Spawning and rearing habitat use by white sturgeons in the Columbia River downstream from McNary Dam. Transactions of the American Fisheries Society 122:217-227.

Parsley, M. J., and L. G. Beckman. 1994. White sturgeon spawning and rearing habitat in the lower Columbia River. North American Journal of Fisheries Management 14:812-827.

Parsley, M. J., D. W. Rondorf, and M.W. Hanks. In press. Remote Sensing of Fish and Their Habitats. Proceedings of the AInstream and Environmental Flows Symposium≅ held in conjunction with the Annual Meeting of the North American Lake Management Society, December 1997, Houston, Texas.

Counihan, T.D., A.I. Miller, M.G. Mesa, and M.J. Parsley. In press. The effects of dissolved gas supersaturation on white sturgeon larvae. Transactions of the American Fisheries Society.

Counihan, T.D., A.I. Miller, and M.J Parsley. Accepted with revisions. Indexing the relative abundance of young-of-the-year white sturgeon in an impoundment of the lower Columbia River from highly skewed trawling data. North American Journal of Fisheries Management.

Alec G. Maule, Research Physiologist, 0.05 FTE

Education

B.A., University of California, Riverside (Psychology) 1969
B.S., California Polytechnic University, San Luis Obispo (Natural Resource Management) 1979
M.S., Oregon State University (Fisheries Science) 1982
Ph.D., Oregon State University (Fisheries Science) 1989

Employment

Assistant Professor of Fisheries (Courtesy), OSU (1991-present)
Adjunct Associate Professor of Biology, Portland State University (1992-present)
Research Physiologist, USGS, BRD, Columbia River Res. Lab. (1991-present)

Publications (most recent 5 of 29)

Maule, A.G., and M.G. Mesa. 1994. Efficacy of electrofishing to assess plasma cortisol concentration in juvenile chinook salmon passing hydroelectric dams on the Columbia River. North American Journal of Fisheries Management 14:334-339.

Maule, A.G., D. Rondorf, J. Beeman, and P. Haner. 1996. Incidence and severity of Renibacterium salmoninarum in spring chinook salmon in the Snake and Columbia rivers. Journal of Aquatic Animal Health 8: 37-46. (Finalist for Best Paper in the journal for 1996).

Haner, P. V., J. C. Faler, R. M. Schrock. D. W. Rondorf, and A. G. Maule. 1996. Skin reflectance as a non-lethal measure of smoltification for juvenile salmonids. North American Journal of Fish Management.

Maule, A.G., R. M. Schrock, C. Slater, M. S. Fitzpatrick, and C. B. Schreck. 1996. Immune and endocrine responses of adult spring chinook salmon during freshwater migration and sexual maturation. Fish and Shellfish Immunology 6:221-233.

Beeman, J.W., P.V. Haner, and A.G. Maule. In press. A new miniature pressure-sensitive radio transmitter. North American Journal of Fisheries Management.

Professional Service

I am currently an Associate Editor for the Journal of Aquatic Animal Health

American Fisheries Society
Fish Health Section
Snieszko Graduate Award Committee (Chair) 1989-91
Physiology Section (Charter member)
Vice Pres., Pres.-elect, Pres., Past-Pres. 1993-97
Awards Committee (Chair) 1997-98
Oregon Chapter
AFS Legislative Committee 1983-84
AFS Oregon Annual Meeting, Program Committee 1985-93
Director of Internal Committees 1989-90
Pres.-elect/Pres./Past Pres. 1990-93

Regional Committees

Dissolved Gas Team. 1995 - present.
Grand Coulee Dam Dissolved Gas Committee (Chair) 1996 - present.

Section 10. Information/technology transfer

Research results will be submitted for publication in peer-reviewed journals. The work will also be presented at various meetings and workshops.